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A Distance Ecological Model for Individual and Collaborative-learning support

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Abstract: Under the concept of life-long education, many people from many parts of the social environment will need to be trained and learn about IT. We have started building a framework for such people, as a distance ecological model for self/ collaborative learning support. The purpose of this study is to propose and develop a distance educational model, as a school-based curriculum development and training-system. In this environment, a teacher can learn via an Internet-based self-training system about subject contents, modern teaching know-how, and students' learning activities evaluation methods. This paper describes the structure, functions and mechanism of our distance educational model, in order to realize the above-mentioned goal, and then discuss the educational meaning of this model in consideration of the new learning ecology, which is based on multi-modality and new learning situations and forms, and we perform some tests and evaluation. Moreover, we show an extension of our RAPSODY framework, RAPSODY-EXT, which also embraces collaboration in remote learning environments.

Introduction

Recently, various new teaching subjects and methods using Internet and Multimedia are being introduced throughout the world, and in Japan in particular. Therefore, now-a-days it is extremely important for a teacher to acquire computer communication literacy (Nishinosono (1998)). So far, there were many systems developed for these purposes. In Japan, for instance, systems using communication satellites systems such as the SCS (Space Collaboration System) are developed and used as distance education systems between Japanese national universities. In the near future, a teacher's role will change from text based teaching, to facilitating, advising, consulting, and his/her role will be more that of a designer of the learning environment. Thus, teachers have to constantly acquire/learn new knowledge/methodologies. To help them in this task, we set out to build a free and flexible self-teaching individual environment for them, and at the same time, a collaborative communication environment, to support mutual deep and effective understanding among teachers, by using Internet distributed environments and multimedia technologies. In this paper, we propose a Distance Educational Model, which is based on the concept of School Based Curriculum Development and Training System, advocated by UNESCO (1998) and OECD/CERI (Center for Educational Research and Innovation), and describe the structure, function, mechanism, educational meaning of this model and finally show some preliminary system evaluation. Moreover, we show a system extension, called RAPSODY-EXT, which embraces the previous system, while adding collaboration facilities.

Distance Educational Model based on RAPSODY

The recent technological developments, e.g., the increased computational power of computers and the increased Internet bandwidth, made it possible and facilitate learning of various kinds of subject contents via a virtual school. Figure 1 shows how the material on RAPSODY is built by teachers or specialists, via our cell editing and authoring environment, and how the beneficiaries of this material can be various learners, accessing the system remotely from their working place or from their homes. Moreover, the system allows access to a multitude of individual and collaborative learning tools, like a tele-conferencing environment, supporting environments for problem solving, such as Stella, CASE, distance teaching

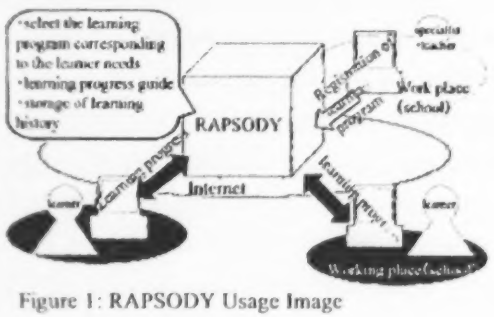

Figure 1: RAPSODY Usage Image

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environments, such as Tele-Teaching, and so on.

Our Distance Educational Model is built on three dimensions (figure 2): the subject-contents unit, the teaching knowledge or skills, and the favorite learning media (e. g., VOD, CBR (Case Based Reasoning), etc.). By selecting a position on each of the three axes, a certain CELL is determined. A CELL consists of several slots, which represent the features/characteristics o f the Learning Object. The meaning of each axis will be explained in more details.

Subject –contents unit

Subject-contents unit represents what the teachers want to learn. In our case, the subject is called "Information", established as a new obligatory subject in the regular courses of the academic high school system in Japan; it is divided into the following three sub-subjects:

Information A: Raising the fundamental skills and abilities to collect, process and transmit "information" using computers, Internet and Multimedia.

Information B: Understanding the fundamental scientific aspects and the practical usage methods of "information".

Information C: Fostering the desirable and sound behavior regarding participation, involvement and contribution in an information society. This sub-subject focuses on understanding peoples' roles and the influence and impact of technology, in the new information society.

Teaching knowledge/skills

Teaching knowledge/skills is defined as: sub-subject contents, teaching and evaluating methods. Among them, 'teaching methods' stands for how to use and apply IT, which involves comprehensive learning activities, such as problem recognition, investigation and analysis, planning and design, implementation and executing, evaluation, report and presentation. We aim at teachers' acquiring the proper students' achievements evaluating skills, according to each of the above activities.

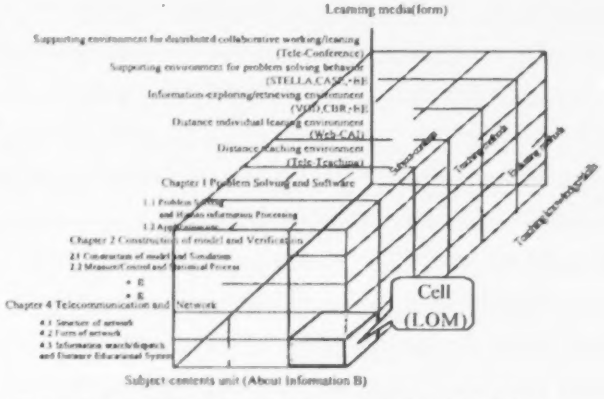
Learning media(form)
Supporting environment for distributed collaborative working/learning (Tele-Conference)
Supporting environment for problem solving behavior (STELLA,CASE-BASE)
Information-exploring/retrieving environment (VOD,CBR+B)
Distance individual learning environment (Web-CAI)
Distance teaching environment (Tele-Teaching)
Chapter 1 Problem Solving and Software
Chapter 2 Construction of model and Verification
Chapter 4 Telecommunication and Network
Cell (LOM)
Subject-contents unit (About Information B)

Figure 2: Structure of the Distance Educational Model

Learning media (form)

This dimension represents five different learning environments, as follows.

(1) **Distance teaching environment (Tele-Teaching):** This environment delivers the instructor's lecture image and voice information via Internet, by using the VOD real-time information dispatching function.

(2) **Distance individual learning environment (Web-CAI)**: This environment provides CAI courseware with WWW facilities on the Internet.

(3) **Information-exploring and retrieving environment**: This environment delivers, according to the teacher's demand, the instructor's lecture image and voice information, which was previously stored on the VOD server. For delivery, the function of dispatching information accumulated on the VOD server is used. This environment also provides a CBR system with classroom teaching practices short movies.

(4) **Supporting environment for problem solving:** This environment provides a tool library for performance support, based on CAD, Modeling tools, Spreadsheets, Authoring tools, and others.

(5) **Supporting environment for distributed collaborative working & learning:** This environment provides a groupware with a shared memory window, with text, voice and image information for the trainees.

"Cell" Definition

Table 1: The Frame Representation of the "Cell"

	Frame-name:	*Slot-value*
Slot-name	Learning objectives for a student	Subjects which should be understood / Subjects which should be mastered
	Subject-contents	The unit topic
	Teaching method	The students ' supervision method and instructional strategies
	Evaluating method	The students ' evaluation method
	Useful tools	The software used for the training activity
	Operational manual of tools	The software operation method used for the training activity
	Prepared media	The learning media which can be selected

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Guide script	The file which specifies the dialog between the trainee and the system

The concept of a "cell" in the Distance Educational Model is quite important, because it generates the training scenario (including information according to the teacher's needs), the subject materials learning-flow and the guidelines for self-learning navigation. The frame representation of the "cell" is shown in Table 1. These slots are used when the system guides the process of the teacher's self-learning.

Outline of the Teacher Training System

The teacher's training environment system configuration is composed of two Distance Education subsystems. One is the training system; the other one is an authoring system with "cell" description creation and editing functions. Details follow in the subsections.

The Training System

The training system aims to support teachers' self-training (figure 3). The role of this system is first to identify a "cell" in the model, according to the teachers' needs, and then, to set up an effective learning environment, by retrieving the proper materials for the teacher, along with the "guide script" defined in the corresponding "cell". Therefore, the system offers programs for both Retrieving and Interpreting. The training system working steps are:

STEP 1: Record the teacher's needs.
STEP 2: Select a "cell" in the Distance Education Model according to the teacher's needs.
STEP 3: Interpret the "cell" in the guide WM (Working Memory).
STEP 4: Develop the interactive training with the teacher according to the "guide script" in the guide WM.
STEP 5: Store the dialog log-data. The log-data collects information on the learning histories and teachers' needs and behaviors.
STEP 6: Provide the needed and useful applications for the user's learning activities and set up an effective training environment.
STEP 7: Give guidance-information, according to the "cell" script guidelines, and decide on the proper "cell" for the next learning step.

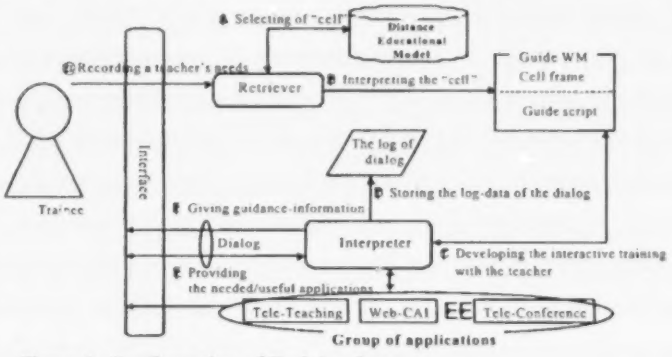

Figure 3: Configuration of Training System

Here, it is necessary to explain the dialog mechanism (algorithm) between user and system. The interpreter controls and develops the dialog process between user and machine according to the information defined in our "guide script" description language (GSDL), consisting of some tags and a simple grammar for interpreting a document, similar to the HTML on the WWW. The interpreter understands the meanings of the tags, and interprets the contents. An example of GSDL is shown below.

(1)<free> Definition: description of the text (instruction)
(2)<slot (num.)> Definition: a link to a slot value in the "cell"
(3)<question> Definition: questions to a trainee
(4)<choice> Definition: branching control according to a trainee's response
(5)<exe> Call: to relevant "cells"
(6)<app> Definition: applications used for training activities (e.g., Tele-Teaching, etc.)

Figure 4: Training System Window Interaction: first page, message windows, lecture video, message board

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Authoring System for Creating and Editing a "Cell" Description

The system (see, figure 5) provides an authoring module to create and edit the information in the "cell". This module also offers the function of adding new cells, in order to allow supervisors (experienced teachers) to design the teachers' training program. This system is composed of the cell frame creating module, and the "guide script"-creating creating module. A cell design is shown as follows.

STEP 1: Get the "cell" slot-values: "student's learning objectives", "subject-contents/teaching/evaluating method", and " useful tools".

STEP 2: Substitute the return value of the slot of the prepared media with the training-contents corresponding to the user's needs.

STEP 3: Substitute the slot-value in the "cell" for the corresponding tag in the "guide script" template.

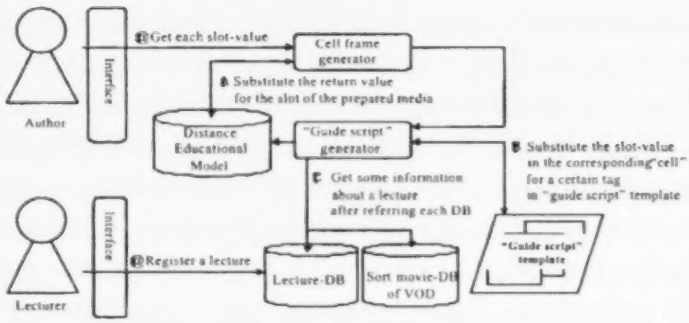
Author
Interface
Get each slot-value
Cell frame generator
Substitute the return value for the slot of the prepared media
Distance Educational Model
"Guide script" generator
Substitute the slot-value in the corresponding"cell" for a certain tag in "guide script" template
Get some information about a lecture after referring each DB
"Guide script" template
Lecturer
Interface
Register a lecture
Lecture-DB
Sort movie-DB of VOD

Figure 5: The Procedure of "Cell" Description for Creating/Editing of the Authoring System

STEP 4: If "Tele-Teaching" is selected, get information about the lecture, by referring the lecture- and VOD short movie-DB.

STEP 5: Add the new "cell" to the Distance Educational Model.

The lecture-database consists of "lesson managing files" containing user-profile data, lecture schedules, trainees learning records, lecture abstracts, and so on. The "guide script" template file contains tag-information, written in the "guide script" description language (GSDL), for all subject-contents items in the Distance Educational Model.

Evaluations and Tests

To inspect the usefulness of our system, we carried out some evaluation experiments. Subjects/ testees were future teaching staff, training in universities, as well as already presently enrolled teaching staff, undergraduate students, and finally, people just interested in information education. From the point of view of practical usage of the system,our goal was to provide the user with a "school" in the actual spot where the teacher/user is ,be it workplace or home, and allow access via the various existing network environments. The system usage form can be classified therefore as:

a) Computer connected via a relatively high-speed network	at a university or at a workplace institution;
b) Computer connected via a low speed network	at the workplace or at home. In the latter case,the system has to be able to prove enough practical use even for the low speed net.

The evaluation of our system can be conducted from two points of view:

a) Educational effect of the staff training
b) System operationality & functions; next we will report the evaluation experiments results concerning this point.

We performed an experiment involving as testees 19 teaching staff members and 14 undergraduate students. We classified the testees according to the network speed of the used environment into:

home (modem.	home.ISDN.	workplace (modem)	workplace(ISDN)	workplace/university (LAN)
5 people	4 people	0 people	16 people	8people

The testees had to use the system for a minimum of 2 hours to perform self-training. Moreover, we set up the following experimental conditions for the separate training and designing sessions:

(1) The testees with specific interests about some information items would select the training program according to those interests, and then proceed with their training. The testees with no clear goal , would select the "communication and networks" training program and then proceed with their training.
(2) The testees had to implement also at least 3 training programs, by using the cell construction & editing system.

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Before enacting the experiment, the distance education modem database contained already 37 training programs. After more than 2 hours system usage, the testees were asked to fill in a questionnaire that contained 34 questions, organized according to points of view of such as "easiness; convenience "."functions" and "computer environment". Except for questions related to the "computer environment", evaluation was performed on a linear scale of 0 to 5 points. In the following,the questionnaire result is presented and analyzed.

Firstly, we will present the results regarding the self-training system. The average evaluation results for the questions "*Did you manage to select a training program that contained novelties for yourself?*", "*Were the message number and contents displayed in the message window and the indication methods appropriate?*" was 3. 7, so high. However, the evaluation results of the questions "*Was the number of training programs(candidates) for the next step training activity in the training program list sufficient?*" were 3. 2, so relatively low. Moreover,the response dispersion of 0. 17 was,compared to the dispersion of other questions,0. 006~0. 1., high. We think that it is possible to improve this by having more candidate inputs for each training program, and implementing improved training program lists.

Next,we will present the results according to the cell construction/editing system. The evaluation regarding the question "*By using the connection/ relation editor, did you manage to design links well?*" had an average of 3. 5, so was highly evaluated. However, the question "*Did you manage to build scenarios well by using the Guide-Script Editor?*" was evaluated with a low average of 2.9. This is due to the fact that the context types defined in the Guide-Script editor were not enough. Moreover, many testees have answered that it was difficult to construct with the editor, as the contexts available for composing scenarios were only 6, and there were many constrains. Therefore, it is necessary to re-analyze the context types. We are currently investigating a description method that allows more degrees of freedom and more available contexts. We have prepared also 4 questions regarding the item "Computer". The global evaluation resulting from all questions had an average of 3. 5, so was relatively high and promising.

RAPSODY-EXT: Collaborative Learning Environment Extension

The main collaborative learning extensions of RAPSODY-EXT over the previous RAPSODY system include: (1) basic equipment of Synchronous /Asynchronous collaborative learning, (2) Synchronous /Asynchronous collaborative learning materials development facilities, and (3) Synchronous /Asynchronous collaborative learning support function supplement.

The extension of RAPSODY-EXT over RAPSODY can be seen in figure 6. The most important are the collaboration learning support tools, that have to do goal oriented work path planning, to select the tool(s) offering the common working environment, to function as a work history registration/ administration tool, and finally, to do manage results. In this way, RAPSODY-EXT becomes a remote and adaptive educational environment and, at the same time, a dynamic communicative system for collaborative learning and WWW synchronous and asynchronous collaborative learning support. Therefore, the RAPSODY-EXT extended system also features: (1) Synchronous or asynchronous collaborative learning group - or individual portfolio construction, (2) Collaborative activity logging in the collaborative memory, (3) Portfolio and collaborative memory knowledge management, and (4) Offer of various directory information

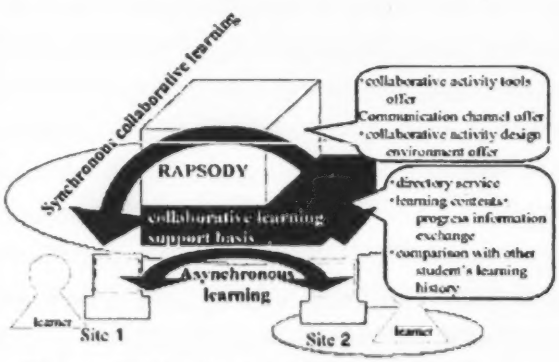

Figure 6: Collaborative Learning environment

We base many of our management function implementations on one of the strongest tools in collaborative environments, agent technology, which we have not gone into details about in the current paper. Beside of performing low-level management functions and communication functions, agents can build user models, infer interpretations, simulate students or teachers in the collaborative environment, therefore implying different levels of intelligent processing (Dillenbourg, 1999).

Group and Individual Portfolio Construction

Depending on the collaborative learning style (synchronous/ asynchronous), an individual/ group portfolio is created as a collection of log data about important collaborative activities. Concretely, the following mechanisms are offered: communication message management and knowledge management. The communication management

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function is software acting at a higher level than the learner computer terminal and the collaborative learning management server. Depending on the learner's terminal, the learner data for communication is collected from public and shared applications, is grouped according to the communication message type (data development time stamp, learner ID, message attribute, shared application operation data, etc.) and sent to the collaborative learning management server. On the server, the communication message received from the learner computer terminal is handed over to the knowledge management mechanism. This mechanism does a structure analysis of the message received from the communication message management mechanism, and arranges and integrates the new data with the already accumulated data available in the collaboration learning management database.

Knowledge Management of Collaborative Learning Data

The main goals of the knowledge management in RAPSODY-EXT are to link the information stored in the Collaborative memory to reflect each learning stage. We distinguish between the following two main categories: *Text information management*, as in, for instance, concept information extraction: extracted concept dictionary, "on the fly" dictionary; data mining process: computational (frequency, mutual frequency), conceptual (topic/viewpoint, etc.); information visualization: task dependent (word processor, task viewer, etc.), task independent (SOM, state diagram, etc.). *Non-textual information management*, as in the mining process via information gain machine learning methods: ID3 (C4.5), decision trees; information visualization: NN usage: SOM, Symbolic "map" generation.

Conclusions and Discussion

This paper proposes a Distance Educational Model called RAPSODY that stands for the networked virtual learning environment based on a three dimensional representation, with the axes 1) subject-contents, e.g., "information", 2) teaching knowledge and evaluation methods and 3) learning and teaching media (forms). This represents a new framework for teachers' education in the coming networked age. We have shown the system rationale and explained the architecture of the 3D-representation model training system. Furthermore, we have described a "guide script" language for cell building. Some of the cell contents design represents the research of other Doctoral students and researchers in our laboratory, and was presented at different other international conferences. For instance, a VOD system for classroom teaching video retrieval is being built, for providing teachers with several examples of teaching practice, classified from different points of view and focusing on different aspects of the teaching process. Another example is a CBR system for teachers. Another line of research involves CAI systems, as, e.g., an individualized system for self-training and upgrading in the Neural Networks domain, and an agent-based adaptive system for academic English teaching. The main aim of our system is to support teachers' self-learning, provided as in-service training. At the same time, we need to build rich databases by accumulating various kinds of teaching expertise. In this way, the "knowledge-sharing" and "knowledge-reusing" concepts will be implemented. With this system, we can construct various kinds of learning forms and design interactive and collaborative activities among learners. Such an interactive learning environment can provide externalized knowledge-acquisition and knowledge-sharing, via the communication process, and support learning methods such as "Learning by asking", "Learning by showing", "Learning by Observing", "Learning by Exploring" and so on. Among the learning effects expected from this system, we also aim at meta-cognition and distributed cognition, such as reflective thinking and self-monitoring. Therefore, through this system we expect to build a new learning ecology. Finally, we made preliminary functionality tests with the actually implemented system, which have shown us some of the current strengths and weaknesses of the system, and pointed to the future developing directions. For future research, we have to evaluate the system's effectiveness and usability as a whole from educational point of view.

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